



## Project X-51: The Paper Project

NASA Rockets Guide, Paper Rocket Alternative

Adapted by Rick & Ellyssa Varner

**Objective:** To apply the basic concepts of the Engineering Design process to design, construct, test and launch a compressed air paper rocket in a simulated real-world, problem solving simulation.

**Description:** Engineering design teams of students will be tasked with the design and construction of a paper rocket that adheres to budgetary and deliverable time constraints. Each student team will manage a budget for materials and services and complete project reports for their progress. The instructor will establish the targets for a satisfactory launch performance and deliverable outcomes to be achieved during the unit.

*This activity is an adaptation of a water bottle rocket unit originally designed in the NASA Rockets Educator Guide. The paper rocket adaptation allows for a more conservative expenditure of funds for materials and a quick design, construct, test, redesign and launch engineering design cycle.*

Shearer, Deborah A. M.S. and Vogt, Gregory L. Ed.D., *Rockets Educators Guide*, Shearer Vogt and Associates, LLC, *NASA Project X-51*, **NASA Product Number: EG-2011-11-223-KSC**, [http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Project\\_X\\_51.html](http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Project_X_51.html)

### Materials:

#### **Launcher**

PVC & 2 liter bottle **Pop! Rocket Launcher** as described in the NASA Rockets Educator Guide,

[http://www.nasa.gov/pdf/295790main\\_Rockets\\_Pop\\_Rocket\\_Launcher.pdf](http://www.nasa.gov/pdf/295790main_Rockets_Pop_Rocket_Launcher.pdf)

Spare 2 liter bottles with inserted and taped  $\frac{1}{2}$ " PVC inserts

#### **Rocket Materials per Team with associated budgetary costs**

8  $\frac{1}{2}$ " x 11" copy paper (Graph paper may be used to support area mathematics outcomes)

Clear plastic or cellophane tape

Tools: plastic ruler (with metric), protractor, scissors

$\frac{1}{2}$ " PVC pipe (minimum 12" length)

Student Sheets

### Management:

Prior to the start of this unit, the instructor will need to construct the **Pop! Rocket Launcher** and have at least one of the launchers available for students' testing and comparisons during the construction and testing phases.

Students should be familiar with the Engineering Design Process, adding and subtraction skills, the use of rulers for linear measurements, protractors for determining fin angles, and concepts related to forces and motion appropriate for their respective grade level.

Achieving the greatest distance for their rockets during launch sequences motivates most student groups. Relative distances are easily marked in fields or on gymnasium floors for measurement, but alternate outcomes may be used. Example: launching rockets with a specific target, such as a laundry basket or hula-hoop or launching "rocket sleds" down hallway floors awarding performance points related to the closeness of the landing to this target.

The unit may be scaled upward to include calculations for altitude and estimated average speeds. Advanced construction techniques may be expanded to include upper stages and parachute recovery systems as described in other NASA guides and center web sites.

The students should be divided into teams of three. The materials from the original unit may be used for the purpose of defining the student positions within each team. These positions are:  
Design & Launch Director, Budget Director, and the Project Manager

The original NASA unit includes identification badges with position responsibilities. It is suggested that digital images of the students be inserted onto these badges. Photo ID's are not essential to the unit, but lend a nice touch to the simulation and offer a subtle reminder for those students who tend to under or over-reach their roles within the dynamics of the team. Additional roles may be created at the classroom level to assist the instructor in the management of supplies, billing for supplies and services for testing and launching. These students would not be assigned to individual rocket teams, but would instead be members of an administrative project management team.

While the water rocket unit is designed for nine meetings, the paper rocket version may be completed in a collapsed time frame as a result of the simplified use of materials. The first meeting should remain as an introductory meeting to set the teams, establish the proposal parameters and outcomes. Each team may be encouraged to design a company name and logo to adorn their project journal.

## Paper Rocket Design Team Unit

### Request for Proposal

America's space program has invited the nation's commercial aerospace companies to become more engaged in the competitive design and construction of the next generation of rockets to fly in low Earth orbit. As a part of this process, each company will submit a competitive proposal to receive funding for this project. Budgetary awards will be presented based upon the merits of the team's proposal in three tiers of funding:

Tier One: \$1,000,000,000 Tier Two: 50,000,000 Tier Three: 30,000,000

#### **Initial Proposals must include the following:**

#### **Project Journal (Team Notebook submitted in a 3-prong pocket folder)**

##### **Completed for Initial Submission**

1. Creative Cover with the company name & logo
2. Certificate of Assumed Name (fully completed)
3. Rocket Measurements for Scale Drawing
4. Scale drawing and plan for the paper rocket
  - Body tube, nose cone and no less than three directional fins
  - Two views: side and rear views
  - Metric measurements (centimeters)
5. Develop a projected budget for the project

##### **Included in Proposal for Initial Submission-to be completed upon award of funding**

6. Balance Sheet
7. Canceled Checks stapled to the page in ascending numerical order (3 to a page)
8. Pre-launch analysis and testing
9. Rocket Launch Day Log
10. Score Sheet

## Project Budget Information

Each contractor team will be responsible for accurately managing their project budget. You may generate additional funds by providing contracted services under separate contracts within your classroom and through bonuses received as incentives for innovations or achieving exemplary outcomes during testing. Projects operating in the “red” or spending more funds than budgeted will receive demerits to their scores (grades). If your project has no funding at the time that launches are to occur, your team will not be able to purchase rocket fuel to launch.

Approved Subcontractor List		
Subcontractor	Item	Market Price
AeroJax Equipment Rental	Scissors	\$10,000/period
	Ruler	\$10,000/period
	Restocking Fees (materials case not properly reset)	\$20,000
Graph E Tee Rental	Color Pencils (3)	\$35,000/period
Adhesion Tape & Glue Co.	Masking Tape/12cm	\$50,000
	Cellophane tape/12cm	\$60,000
	Glue Stick usage for 1 period	\$100,000
International Paper Products	Card stock/sheet	\$100,000
	White copy paper/sheet	\$75,000
	Prototype Graph Paper ( <b>required</b> )	
	• Body Tube/sheet	\$80,000
	• Fins/sheet	\$50,000
	Index Card/3” x 5”	\$30,000
Heavenly Air Corporation	Rocket Launching Fuel/2 liter Bottle	\$50,000
Spaceport USA	Launch Facilities	\$100,000
Cal Q. Later Accounting	Budget Audit Service	\$100,000
Aerospace Consultations	Questions	\$5,000
		\$

All materials purchased through the officially approved contractors listed will be charged the cost of materials posted.

The following materials supplied from home and added to the Approved Contractors List supplies for the class project will be purchased from the contractor team and the value added to the team budget in the following amounts:

Cellophane/Clear Tape on plastic dispenser	\$50,000
Color Index Cards 3” x 5”	\$60,000
(1) 2 liter bottle without label (cleaned)	\$50,000

Any materials not on the subcontractors list will be assessed an Originality Tax of \$5000 per item.

A Project Delay Penalty Fee will be assessed for teams not working on-task, lacking materials or other behaviors that deter progress on the funded project. The maximum penalty may not exceed \$300,000 per period.